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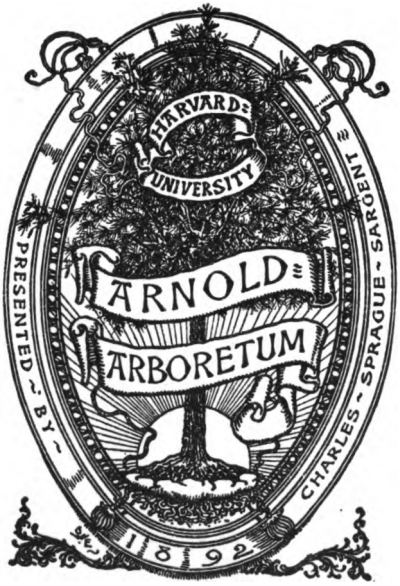

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YELLOW BIRCH AND ITS RELATION TO THE ADIRONDACK FOREST

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TABLE OF CONTENTS

YELLOW BIRCH AND ITS RELATION TO THE ADIRONDACK FOREST

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INDEX OF PLATES AND FIGURES

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YELLOW BIRCH AND ITS RELATION TO THE ADIRONDACK FOREST

The importance of hardwood in the Adirondack forest mixture when establishing plans for management was early recognized by Dr. B. E. Fernow, and active steps were taken to bring into the Adirondack regions industries that could utilize the hardwoods. The present study of yellow birch was undertaken to better acquaint us with its relation to the future forest crop. While it is but one of the four important hardwoods found in the Adirondack forest mixture, it has been selected for study for reasons which demand for it first consideration in the judgment of those members of faculty of the College of Forestry who have undertaken the work.

A complete study of the yellow birch (*Betula lutea*) was planned by the Research Committee of the College, and the work was started by several departments. This report covers the investigations of a field party of five men during the summer of 1919, together with some data previously collected. The results substantiate the previous judgment of the committee as to the importance of an inclusive study of this species.

This report includes a fundamental discussion of the types and conditions found in the Adirondacks, and presents comparative data to show the silvicultural relation of the birch to the other species native to the region. Since the study is a part of a larger work on the birch, it is all presented under the title heading of yellow birch.

The conditions which give rise to the importance of the yellow birch are due to the complex nature of the Adirondack forest and the changing values in its utilization. While the birch is not found throughout the virgin forest, it is found in the major portion and the important types. With this statement in mind, the facts that led to the study may be enumerated, and a specific discussion of its relation to types presented later.

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Facts Leading to the Study:

The following premises are the result of close study of the published reports, constant observation of the forest of the western Adirondacks for a period of three years, and intermittent observation covering eight years. All types and conditions of the forest were under observation during all seasons for the three years mentioned. The measurements made during 1919 are in accord with the observations previously made, and with the following premises:

1. Yellow birch is the most generally distributed hardwood species in the true northern forest of the Adirondack region. Not only is it preponderant among the mature hardwoods on the average Adirondack acre, but it extends most widely through the range of types.

2. Yellow birch possesses certain advantages over the three important competing hardwoods—beech, sugar maple, and red maple—in seizure of devastated areas.

Its seeds are more motile.

Its seed crop occurs in quantity annually, and has few enemies.

Its seeds can germinate on deep humus or partially decayed wood, and take root successfully through deep layers of such material to the mineral soil.

The species in its seedling and young sapling stages grows with sufficient rapidity to compete with tolerant hardwoods and assure the tree of a dominant place in the ultimate stand of trees of the same age.

3. The crown of the birch intercepts less light than those of the maples and beech, so that it allows a better growth of the understory of softwoods by reason of this and other factors of tolerance.

4. Cut over lands are observed to have dense stands of young birch, and it is believed that the ultimate forest will have a larger percentage of birch than the virgin forest, which will increase its importance in the industries, and further enhance its value.

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Type

The Fundamental Importance of Type:

Division of a forest area into types is quite as necessary, for purposes of management, as it is to obtain facts that can be converted into working principles. Operations on any extensive Adirondack area, even in logging, bring out the differences in forest composition and topography, and these differences have been used to define the major types of the region. Any study which ignores these differences will cause to be lost, by the law of averages, the facts that might be developed into rules of management. While this publication recognizes the four major types of the region for the sake of common understanding, very little intensive work can be accomplished until a *more minute division* is made and the physical factors which create the minor differences are recognized and studied. Changes in soil depth and composition, drainage, depth of humus, forest composition and even shrub and herbaceous cover all react to cause differences in forest reproduction within a type.

While the four major types are used as the basis of this study, other types are mentioned and described, and minor differences are pointed out.

Swamp:

This type is of small importance in a study of yellow birch in virgin forest, since birch does not enter into the forest as a merchantable tree in the true type. Any study which reports birch as part of the swamp type in its tables does so because the tree appears on the margin of the type and on knolls, or well-drained spots where the small size of the area prevents elimination from the type. The area of swamp will be reduced in the second growth forest on cleared areas by encroachment of both birch and red maple from the margins.

The true swamp type of the Adirondack region is a balsam and spruce mixture on flat, poorly drained land. There may be areas along streams and lake margins where cedar and hemlock are prominent. Tamarack, as the temporary species of such swamps, was once plentiful, but the mature trees are now dead, and tamarack occupies only bog margins in the virgin

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swamp type. White pine as a member of the swamp mixture is found occasionally due to slight variation in topography and soil site.

The soil may be deep or practically lacking, as on some boulder formations, but the permanent water table is generally so high as to make natural swamps a poor site for tree growth. The floor of the forest is spongy with common occurrence of sphagnum.

Effect of Drainage on Swamp Mixture:

The typical tree of the undrained swamp is black spruce, and any appearance of balsam in the mixture is evidence of a flow of water in that area, either by seepage or direct stream drainage. The margins of bog swamp areas may have balsam in mixture and may be as wet to all appearances as the spruce section of the bog, yet there is doubtless movement of water from the higher land through the balsam section of the swamp which brings about the change of mixture commonly observed.

The Stunted Spruce and Open Bog:

Open heath covered bog with stunted growth of black spruce occurs over considerable areas of the undrained swamp type.

A slight rise of the water table in such swamps is soon apparent in the loss of vigor and death of the spruce, while an equivalent lowering of the water table will result in a distinct recovery of the stunted trees and more rapid growth. This variation of the commercial swamp type offers possibilities of drainage in many places which will react favorably in introduction of species from the higher ground. Young birch trees often invade this type where drainage permits, but these fail to mature or produce dwarfed specimens. The swamp type has a normally high percentage of windfall due to the poor root support, so that the existing forest is usually young as compared with the upland types. The outer margin of the swamp may be defined as the line at which a soil layer of depth sufficient to sustain mature hardwoods exist above the water table, and where the floor of the forest loses its spongy character. Yellow birch appears in commercial size at about this line, and is surpassed by the red maple only in ability to take a wet site.

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Graves (1) gives the number of birch on swamp land among trees ten inches and over in diameter at breast height as thirteen per acre, or 18.33 per cent of the total stand. This was an average of 225 acres.

Hosmer and Bruce (2) similarly give 2.72 birch trees per acre, or 7.44 per cent of the total number on an average of ninety acres.

Tables I and II show the composition of two typical swamp areas. Hardwoods were marked cull in case they had no present merchantable value, or, if small, had reached such a condition that they would never become merchantable. The reproduction count was made on square rod sample plots well distributed over the areas.

These are given to show the composition of the swamp type in its relation to birch. Birch reproduction was found farther in from the swamp margin than the mature trees.

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TABLE I

VIRGIN STAND IN N. W. ½ TWP. 1—MACOMBS GREAT TRACT NO. 2

Represents the average of 11.4 carefully run acres. Softwoods calipered to inch classes and hardwoods to even inch classes.

Swamp Type, Virgin

NUMBER OF TREES PER ACRE BY SPECIES AND DIAMETER CLASSES

D. B. H. ob,	Spruce	Windfallen spruce	Balsam	Windfallen balsam	Sound yellow birch	Cull yellow birch	Sound soft maple	Cull soft maple
2	37.98	0.09	26.00	0.44	0.35	.....	0.09	.....
3	45.90	0.09	35.80	1.40	.....	.....	.....	.....
4	39.60	1.30	35.20	0.62	2.11	1.14	0.09	0.96
5	37.10	0.18	35.20	0.79	.....	.....	.....	.....
6	25.60	1.23	32.90	1.40	3.60	1.84	0.62	0.18
7	22.70	0.35	23.10	1.93	.....	.....	.....	.....
8	14.70	0.61	12.40	1.66	3.77	1.23	0.26	0.35
9	12.70	0.44	9.40	1.14	.....	.....	.....	.....
10	8.30	0.44	5.90	1.40	3.25	0.53	0.96	0.44
11	6.80	1.05	1.93	0.17	.....	.....	.....	.....
12	6.60	0.26	1.32	0.35	2.11	0.61	0.62	0.09
13	3.60	0.09	0.90	0.18	.....	.....	.....	.....
14	2.60	0.44	0.17	.....	1.06	0.53	0.44	0.09
15	2.02	0.09	0.35	0.09	.....	.....	.....	.....
16	1.58	.....	0.09	.....	1.06	0.18	0.35	.....
17	1.28	.....	0.09	.....	.....	.....	.....	.....
18	1.31	.....	.....	.....	0.32	.....	0.18	.....
19	0.35	.....	.....	.....	.....	.....	.....	.....
20	0.26	.....	.....	.....	0.18	.....	.....	.....
21	0.17	.....	.....	.....	.....	.....	.....	.....
22	0.26	.....	.....	.....	0.09	.....	.....	.....
23	0.09	.....	.....	.....	.....	.....	.....	.....
24	0.09	.....	.....	.....	0.09	.....	.....	.....
25	.....	.....	.....	.....	.....	.....	.....	.....
26	.....	.....	.....	.....	.....	.....	.....	.....
Total....	271.59	6.66	220.75	11.57	11.49	6.06	3.61	2.11

Tamarack, total number per acre all diameter classes.....	10.50
White pine, total number per acre all diameter classes.....	0.45
Cedar, total number per acre all diameter classes.....	4.40
Hemlock, total number per acre all diameter classes.....	2.58

RESULT OF COUNT OF REPRODUCTION LESS THAN 1.5 INCHES D. B. H. ON THIRTY-SIX SAMPLE PLOTS SCATTERED OVER 11.4 ACRES OF SWAMP RECORDED IN TABLE I

Number of seedlings per acre	Species	
1,775	Balsam	Majority less than one foot high. All grown under dense shade and not vigorous.
1,480	Spruce	Larger number of seedlings one and two feet high than in case of balsam. Majority ten inches or less in height. None counted which did not show branching.
252	Yellow birch ..	Found near the edge of the swamp and on logs and stumps in windfall openings. Not thrifty.
584	Soft maple	Found along the drainage channels and near the swamp edge.
27	Hard maple ...	Will probably not mature.
12	Hemlock	Seed found favorable site near swamp edge.
8	Beech	
31	Cedar	No evidence of larger saplings to give proof that these will mature.

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TABLE II

VIRGIN STAND IN N. W. ¼ TWP. 1—MACOMBS GREAT TRACT NO. 2

Represents the average of 16.5 acres taken from a swamp of smaller area than that represented in Table I. Hardwoods taken to even inch classes.

Swamp Type, Virgin

NUMBER OF TREES PER ACRE BY SPECIES AND INCH CLASSES

D. B. H. ob.	Spruce	Wind-fallen spruce	Balsam	Wind-fallen balsam	Sound soft maple	Cull soft maple	Sound yellow birch	Cull yellow birch
2	34.18	0.12	25.47	0.12	.....	.....	0.33	.....
3	29.45	0.06	36.27	0.06	.....	.....	.....	.....
4	25.27	0.30	31.76	0.36	0.18	0.18	0.85	0.24
5	25.25	0.24	32.18	0.42	.....	.....	.....	.....
6	20.75	0.48	24.90	0.73	1.15	1.03	1.27	0.61
7	20.24	0.12	21.45	0.54	.....	.....	.....	.....
8	15.76	0.06	16.27	0.73	0.85	1.03	1.23	0.75
9	14.42	0.18	7.09	0.30	.....	.....	.....	.....
10	11.76	0.24	4.42	0.36	0.91	1.09	0.61	0.18
11	8.66	0.18	1.76	0.18	.....	.....	.....	.....
12	6.16	0.12	0.55	0.06	0.55	0.55	0.24	0.06
13	4.60	0.12	0.73	.....	.....	.....	.....	.....
14	2.48	0.06	0.18	.....	0.24	0.24	0.06	.....
15	1.64	0.06	2.24	.....	.....	.....	.....	.....
16	1.82	0.06	0.06	.....	0.12	.....	.....	.....
17	0.91	0.12	0.06	.....	.....	.....	.....	.....
18	0.79	0.12	.....	.....	.....	.....	.....	.....
19	0.31	0.12	.....	.....	.....	.....	.....	.....
20	0.42	.....	.....	.....	.....	.....	.....	.....
21	0.12	.....	.....	.....	.....	.....	.....	.....
22	0.12	.....	.....	.....	.....	.....	.....	.....
Total	225.11	2.82	203.39	3.86	4.00	4.12	4.59	1.84

Pine (white), total of all diameter classes per acre	0.84
Hemlock, total of all diameter classes per acre	2.36
Tamarack, total of all diameter classes per acre	2.12
Black ash, total of all diameter classes per acre	0.48

RESULT OF COUNT OF REPRODUCTION LESS THAN 1.5 INCHES D. B. H. ON NINETY SAMPLE PLOTS SCATTERED OVER THE 16.5 ACRES RECORDED IN TABLE II

SPECIES	Seedlings per acre
Spruce	1,772
Balsam	1,571
Red maple	1,300
Birch (yellow)	182
Pine	18
Hemlock	11
Tamarack	9
Beech	5

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Spruce Flat:

This type has been effectively described by Graves (1), and the chief purpose of discussing it here is to designate its limits so that it may be identified on cut and burned land. The type may be crowded out in some places by the abrupt approach of steep hardwood slopes to the edge of a swamp, and again the spruce flat may cover extensive areas around the swamps on the flats, knolls, and lower ridge slopes. The lower margin extends to the edge of the swamp, stream, or lake and is marked by the appearance of soft maple and birch on a moist soil covered with humus and lacking the spongy characteristic of the swamp.

The upper margin is marked by the disappearance of balsam and appearance of beech in the mixture. The soil loses its humus covering, and there appears instead a shallow layer of hardwood leaf mould with a firm, well-drained soil beneath. Sugar maple is not commonly found in this type. The characteristic species are red spruce, balsam, hemlock, birch and red maple. Graves (1) gives 12.7 birch trees nineteen inches and over in diameter* per acre which is 19.71 per cent of all species on an average of 106 acres. Birch exceeds in number all other hardwood species in the type. The predominance of softwood species, and moist condition of soil when shaded, and extreme dryness when not shaded, influence to a marked degree the reproduction in this type.

Hardwood:

This type has been defined as to its lower margin, and needs only general characterization. While that zone of the ridge slopes having comparatively deep soil may be defined as hardwood type up to the point in elevation where spruce again appears as the dominant, there is still a wide variation in hardwood areas. The amount of moisture and soil depth both influence the composition. The lower, moist hardwood land will have more birch than the better drained parts. Knolls with deep humus are usually covered to larger extent by softwoods.

* Diameter is used to mean diameter at breast height outside bark.

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Areas of several acres may be found covered by stands of pure* sugar maple, while shallow soils on exposed ledges are pure softwood, largely hemlock.

The age of these stands makes marked differences in the forest composition and in the management. Some comparatively even aged stands that are old or decadent show great gaps that are filling again with even aged second growth. Cutting of hardwoods on such areas amounts practically to a clean cutting. Other areas are dense stands of all aged forest suitable to selective cutting without opening the forest to the destructive action of wind and sun.

The hardwood type has reproduced itself by natural selection mainly, yet the characteristic of windfall and even aged growth is common on small areas. Variation in the type is wide, and the composition of the forest changes in the several sections of the Adirondack region. The number of yellow birch per acre ten inches in diameter and over on 442 acres of Nehasane Park is given by Graves (1) as fifteen or 19.06 per cent of the total stand. Table III is taken from N. Herkimer Co., west of Nehasane, and shows an uncommonly large percentage of beech.

TABLE III

AVERAGE NUMBER OF TREES TEN INCHES AND OVER D. B. H. PER ACRE ON 70 ACRES DISTRIBUTED OVER 700 ACRES—NORTHERN HERKIMER COUNTY

Virgin Hardwood Type

Pine	0.53	Beech	26.10
Hemlock	8.47	Maple	8.94
Red spruce	27.30	Yellow birch	13.04
Balsam	1.34	Black cherry	0.56

Upper Spruce Slope:

Yellow birch is the most widely distributed and best developed hardwood tree of this type. It can thrive better than maple or beech on the thin soils, and can reproduce best of all hardwoods in the deep humus found under the type. Birch is given by Hosmer and Bruce (2) as 18.07 per cent, and by Graves (1), 19.52 per cent of the stand. This percentage of

* Term pure used to mean 80 per cent or more of given species.

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birch will not increase if the type is managed as a selection forest.

Influence of Logging on the Forest

The early logging operations may be designated as a selection method, in which the amount of timber removed was not enough to interfere with the crown of the forest, or to make any greater change in its composition than the removal of mature timber itself. In this way the white pine and spruce saw timber was cut and in some localities the large hemlock. Subsequent cutting may be classified under three heads:

1. Cutting of softwood to a diameter limit.
2. Cutting of all merchantable soft wood.
3. Cutting both hard and soft wood as far as it is merchantable.

Cutting of Soft Wood to a Diameter Limit:

The condition of forest resulting from this method of management varies with the lower limit of cutting, the type, and the period in which cutting was done. Such management is the outcome of early agitation for conservative methods following studies made some twenty years ago. The first cut of spruce for pulp was made to a diameter limit of twelve inches at four and one-half feet from the ground, while a later limit of ten inches at the stump height has resulted in removal of practically all merchantable soft woods. Some of the early cutting left the swamps intact and also the hemlock stands. These were then removed in a later cut at a considerable profit resulting from increased stumpage values. Results from this method of cutting have shown after a lapse of twenty years:

1. Heavy windfall of soft woods in the swamps and on thin soiled ledges.
2. Failure of medium diameter classes to recover under the closure of hardwood crowns.
3. Complete depletion of soft wood seed trees on some hardwood acres.

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Reproduction is shown to be largely hard maple and beech on the hardwood type at the expense of the yellow birch where the light cutting was not enough to open up the crowns to allow birch to succeed. This characteristic is so pronounced and important that a table is given to show reproduction under these conditions as compared with clear cutting:

TABLE IV

SHOWING THE NUMBER OF SEEDLINGS AND TREES LESS THAN 1.5 INCHES IN DIAMETER AT BREAST HEIGHT, PER ACRE, BY SPECIES

Hardwood Type

SPECIES	NUMBER PER ACRE	
	Logged to diameter limit	All merchantable timber logged
Pine	0	0
Hemlock	13	2
Spruce	185	454
Balsam	21.4	13
Sugar maple	3,779	83
Red maple	793	900
Beech	1,036	578
Yellow birch	224	2,530
Black cherry	0	36
Fire cherry	0	404
Totals	5,051.4	5,755

Column No. 1 taken from ninety-seven sample plots distributed over thirty-seven acres in northwest ¼, township 35, Totten and Crossfield purchase. This, a portion of the Whitney estate, represents hardwood type which was logged in 1898 to a ten-inch diameter limit, as discussed in F. S. Bul. 26.

Column number 2 taken from 181 sample plots distributed over 680 acres in the southeast ¼, township 15, Macombs Great Tract number 3 (southern St. Lawrence county). Represents same natural type of mixed hard and softwood, logged for both hard and softwood without diameter limit, about 1907.

Cutting all Merchantable Softwoods:

The size of softwoods considered merchantable has varied to such an extent that no standard of result is attainable. On swamps, trees are now cut in some cases to four inches on the stump. This is clear cutting to an extent not known in the Adirondack forest before. On flats and hardwood lands, the removal of merchantable softwood will make the resulting forest more largely hardwoods, but will not exclude softwood reproduction. Some spots will be clear cut, and others will have a comparatively complete crown cover of birch and red maple. When the forest is opened severely, there will be a large mortality due to windfall and exposure.

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Table V shows the result of cutting softwood on the hardwood type. This area, cut over about ten years previous to the study, was covered by a 10 per cent strip survey.

TABLE V

PERCENTAGE OF SPECIES SHOWING CONDITION ON 28.8 ACRES ACTUALLY MEASURED—HARDWOOD TYPE—CUT FOR MERCHANTABLE SOFTWOOD—WEBSTER TRACT—VICINITY OF CRANBERRY LAKE

SPECIES	Condition	Percent of stand
Beech	Sound	33.10
	Cull	12.10
Birch	Sound	18.90
	Cull	2.40
	Windfall	0.50
Maple	Sound	15.10
	Cull	1.70
Spruce	Live	9.50
	Windfall	0.40
Hemlock	Live	6.00
	Windfall	0.13
Balsam	Live	0.15
	Windfall	0.00

Clear Cutting Hard and Softwoods:

In the true use of the term "clear cutting," there has been no removal of this nature carried on in the larger logging operations, since hardwoods of small diameter and cull trees are left standing. Data are presented on a study of hardwood type cut for all merchantable hard and softwoods.

Hardwood Type:

A caliper record of all trees one-half inch D. B. H. and up was taken on strips one chain wide over 20 per cent of the area. A total of 12.2 acres was calipered. In addition, plots one rod square were laid out at two-chain intervals, and all trees less than one-half inch were counted. Height growth was measured on dominant trees of mean diameter over one-half inch. In this way, the average growth of the dominant reproduction in each species was determined. A special study was made on spruce by measurement of the growth of the last twelve years on

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trees one to ten feet high twelve years ago. The results are recorded in Tables VI, VII, and VIII.

Attention is called to the important facts brought out.

1. The numerical predominance of hardwood reproduction.
2. The importance of yellow birch in the young stand.
3. The failure of hemlock reproduction.
4. The prevalence of fire cherry and absence of the aspen.

   (This area had not been burned and fire cherry came on softwood knolls where humus is deep.)
5. The change of the mixture from sugar maple on the higher and drier land to birch on the lower zone in the type where seepage is a more important factor.
6. The more rapid growth of hardwoods than spruce during the first eleven years, the former reaching a height from the seed in the least instance of 10.1 feet as against 5.16 feet in the case of the spruce advanced growth.

There is evidence, as shown in Curve 2, Figure 2, that the spruce has already been checked by the shade of the young hardwoods, and must pass through a period of suppression and await the removal of the hardwood second growth crop. In comparison with Curve 1 which represents the rate of growth of spruce under pole stand of yellow birch, Curve 2 shows a slow rate of height growth for four years after cutting, followed by a sharp recovery exceeding that of Curve 1.

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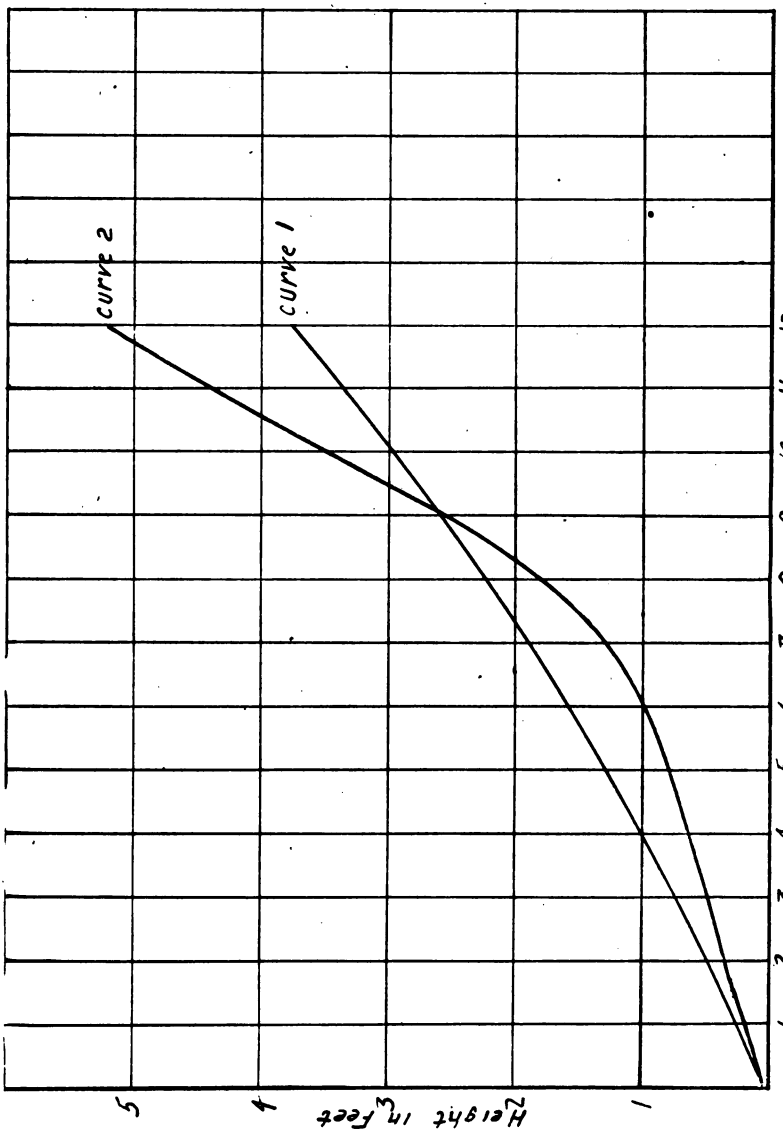

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FIGURE 2

Height growth of red spruce for last twelve years, on trees one to ten feet high twelve years ago.

Curve 1 — One hundred and fifty-three trees in northern Herkimer County, grown under sixty-year old dense pole stand of yellow birch.

Curve 2 — Ninety-three trees on 12.2 acres near Wanakena—logged eleven years ago and now competing with second growth hardwoods.

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TABLE VI

NUMBER OF TREES PER ACRE BY SPECIES AND DIAMETER CLASSES (AVERAGE OF 12.2 ACRES ACTUAL CALIPER RECORD), HARDWOOD TYPE, CUT ABOUT ELEVEN YEARS PREVIOUSLY FOR HARD AND SOFT WOOD, NEAR WANAKENA, IN SOUTHEAST ST. LAWRENCE COUNTY, N. Y.

D. B. H. inches ob.	Yellow birch	Red spruce	Sugar maple	Beech	Hemlock	Balsam	Red maple	Fire cherry	Black cherry	Aspen	Black ash
0*	1696.00	96.00	1294.00	1092.00	25.00	14.00	834.00	148.00	78.00	8.00	37.00
1	145.90	23.60	111.40	92.30	.....	24.00	128.40	196.00	22.10	2.13	.....
2	7.78	11.10	2.70	6.73	.....	.....	3.28	174.40	5.00	0.24	.....
3	2.56	9.03	0.738	6.90	0.082	0.082	.....	31.62	0.24	.....	.....
4	2.03	7.95	0.41	4.75	0.164	0.082	0.082	1.72	.....	.....	.....
5	2.95	3.04	0.24	2.05	0.41	.....	0.24	.....	.....	.....	.....
6	1.38	3.12	0.903	2.00	0.903	.....	0.082	0.082	.....	.....	.....
7	7.38	1.72	0.82	2.05	0.903	0.082	0.164	.....	.....	.....	.....
8	1.23	0.903	0.164	2.62	0.49	.....	0.082	.....	.....	.....	.....
9	1.14	0.24	0.33	1.80	0.903	.....	0.41	.....	.....	.....	.....
10	0.738	0.082	0.49	1.31	0.082	.....	.....	.....	.....	.....	.....
11	0.82	0.082	0.164	0.98	0.082	0.082	0.164	.....	.....	.....	.....
12	0.57	.....	0.082	0.57	0.082	.....	0.082	.....	.....	.....	.....
13	0.41	.....	0.164	0.49	.....	.....	0.24	.....	.....	.....	.....
14	0.41	.....	0.164	0.74	0.082	.....	0.33	.....	.....	.....	.....
15	0.24	.....	0.164	0.33	.....	.....	.....	.....	.....	.....	.....
16	0.164	.....	.....	0.082	.....	.....	.....	.....	.....	.....	.....
17	0.164	.....	.....	0.24	.....	.....	0.164	.....	.....	.....	.....
18	0.41	.....	.....	0.082	.....	.....	.....	.....	.....	.....	.....
19	.....	.....	.....	0.082	.....	.....	.....	.....	.....	.....	.....
20	0.164	.....	.....	.....	.....	.....	0.082	.....	.....	.....	.....
21	0.082	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22	0.41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24	0.082	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	0.33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	0.41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
27	0.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	0.082	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
32	0.164	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
33	0.082	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
34	0.082	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	1874.404	156.867	1412.933	1218.106	29.177	38.328	967.802	551.822	105.340	10.370	37.000

* Reproduction less than one-half inch D. B. H. counted on square rod sample plots five per acre.

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TABLE VII

TOTALS BY ZONES ON SAME AREA FOR TWO SPECIES ONLY (AVERAGE OF 12.2 ACRES)

	LOWER ZONE		MIDDLE ZONE		UPPER ZONE	
	Birch	Sugar maple	Birch	Sugar maple	Birch	Sugar maple
Average number per acre.....	168.8	36.3	135.3	100.0	100.9	338.7

TABLE VIII

HEIGHT OF TREES ON SAMPLE PLOTS AND AVERAGE DIAMETER TAKEN FROM SAMPLE PLOTS ON 12.2 ACRES NEAR WANAKENA, N. Y.

Hardwood Type

SPECIES	D. B. H. inches ob.	Height in feet
Yellow birch.....	0.8	11.0
Sugar maple.....	0.67	10.8
Red maple	0.85	11.0
Beech	0.8	10.1
Fire cherry.....	1.45	*Not taken
Black cherry.....	1.0	14.0

* Not regarded as of sufficient economic value for consideration.

In Connection with Table VIII:

The total height growth of red spruce during the eleven years preceding the study was 5.16 feet. During the first four years the growth shows little acceleration over that of virgin forest conditions, but after that time a rapid recovery was made. The mean annual growth in height for the last four years was 0.83 of a foot which shows some inclination to lessen, due probably to shade of the hardwoods. The measurements were made on trees 1 to 10 feet high at the time of cutting.

Spruce Flat:

A typical area was selected and permanent sample plot established to show the history of this type under this condition. The area was logged eleven years previous to the time of the study. This acre will be remeasured at periodic year intervals,

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so care was taken to establish permanent corners and lines. Trees above four inches in diameter were numbered and recorded, while all others down to the one-inch class were calipered. Brush piles and waste areas were mapped, stumps, stubs and windfallen trees calipered and mapped. In this way a complete restoration of the original forest was effected, also the stages of its destruction.

This permanent sample plot is one of two established in cooperation with the New York Section of Society of American Foresters. The entire plan incorporates all types and conditions of the Adirondack forest, and will establish important facts in regard to its natural replacement.

The history of this acre is shown graphically in Figure 3. While the area is too small to claim that it represents average conditions, some important facts are obvious:

1. The brush piles cover areas shown in shade, and still prevent, after eleven years, the reproduction of forest on these spots (Figure 3a). Camparison of Figures 3d and 3f show the natural change in the forest due to windfall and death from exposure since the logging operation. The crown cover at the present time is open, and the ground covered largely by red raspberry bushes. Over the entire acre, a layer of soft wood humus covers the soil in a depth varying from a few inches to one foot. Figure 3e may be called the mortality record. The count of reproduction showed less than 8 per cent of softwoods, and among hardwoods, soft maple held the dominant place followed by yellow birch. The presence of deep humus and the fact that this dries severely on exposure to the sun prevents tree seeds from germination and checks the growth of seedlings. Although the influence of this condition is most marked on burned lands, its effect appears on cutover lands wherever the soil is exposed to direct sunlight. The first cover is raspberry bushes, and these are not in foliage early enough to protect the germinating softwood seedlings. The ultimate shade of fire cherry and aspen brings about establishment of other reproduction.

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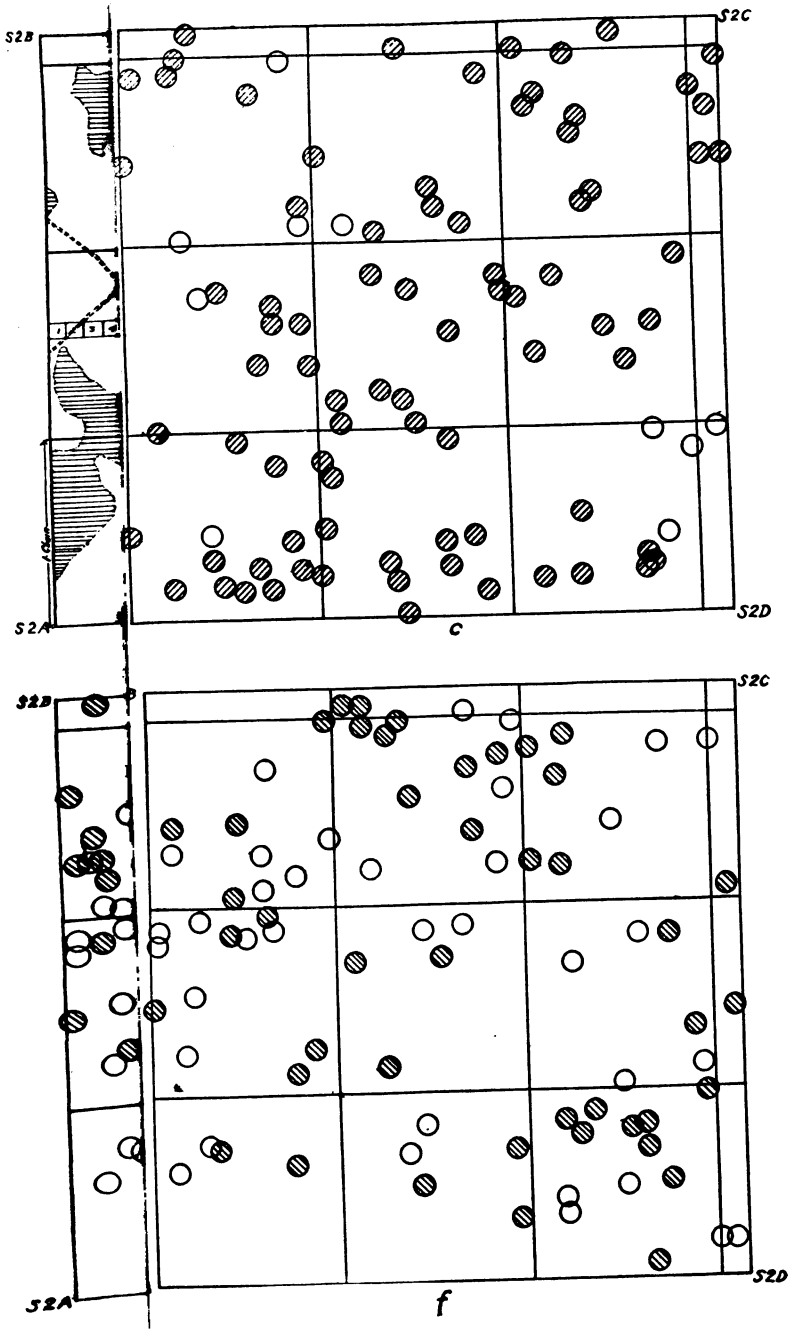

a. Manter. *b.* Original forest. *c.* Trees logged from 19; softwoods shaded; hardwood not shaded.

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Planting on Cutover Land

The discussion thus far has tended to define the types of the Adirondacks and the conditions created by logging operations. Because of the need of softwood to supply the established industries, production of the maximum amount of softwood consistent with good forest economy is a principle of management in this region. Observation of the general tendency of cutover lands to increase their percentage of hardwood led to an examination of plantations to determine their success.

The oldest of plantations within the region studied is about twenty years, placed largely on open or burned over land. Such plantations have demonstrated their success in many instances and covering a wide range of species. The difficulty presented is that of getting cutover land free from slash, bushes, and hardwood young growth without running fire over the land first. No single instance could be found where clear cut hardwood land had been planted without first burning and had lived to reach a size suitable to show results. Such a plantation had been made along the Tupper Lake-Wawbeek road but was subsequently burned. The nearest approach to the required condition was found near this same road, on an area planted in 1904 in accordance with experimental plan of the New York State College of Forestry. It is located north of the Tupper Lake-Wawbeek road about three-quarters of a mile west of Wawbeek, and behind a shelter belt of uncut timber. The type is hardwood having a small number of spruce in the mixture. The soil is glacial boulder till and of good depth except for one ledge outcrop. The slope is of medium grade and faces northerly, extending down to spruce flat type on the north edge. All of the old stand of timber was removed, even to the cordwood, and the brush was burned in small piles. Judging from the number of fire-scarred stumps, the burning destroyed a large amount of potential hardwood reproduction.

Strips were run at an angle of forty-five degrees to the plantation rows, four chains apart, so as to include 5.2 acres of measured area. All trees were calipered down to one-half inch, D. B. H., in inch classes.

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Table IX shows the caliper record reduced to an acre basis not curved. The planted species are white pine, red pine, Scotch pine, Norway spruce and blue spruce. The species that have reproduced naturally are red spruce, balsam, sugar maple, red maple, black cherry, fire cherry, aspen, beech and yellow birch.

The comparative numbers of trees planted could not be determined with accuracy since several spacings were included in the study. Blue spruce was not planted in quantity. The presence of red spruce and hardwoods was general over the tract but more prevalent on approaching the timber belt mentioned.

The preponderance of hardwood species, combined with the greater height of any given inch class makes the competition with the planted softwood very keen. Heights were taken at random over the plantation to get the relation of height to diameter for each species in each inch class. They are recorded in Table X with the number of trees measured beside each.

The general impression, created by the plantation and the compiled data, is that the method here used of clean cutting in its true sense with burning of brush has resulted in producing *a mixed hardwood and softwood forest,* and as such is successful. This does not answer, however, the problem of planting hardwood land as ordinarily cut for all merchantable species, nor does any other plantation thus far found in the Adirondacks.

From Table IX, it is worth noting that the number of trees per acre, fifteen years after the establishment of the plantation, is 1,540.79. Of these, 553.33 are planted stock, all softwoods. There are in addition 44.63 native red spruce and balsam, naturally reproduced. The striking thing to be noted is the invasion by natural reproduction into a prepared and planted site, of the great numbers of native hardwoods. These total 942.83, or 61 per cent of the numerical value of the stand per acre. The occurrence of a large number of aspen and fire cherry in this stand is of temporary consideration only, as they are expected to play but a small part in the future forest, whose typically mixed character seems already indicated.

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TABLE IX

NUMBER OF TREES PER ACRE OF PLANTATION, PLANTED 1904 NEAR WAWBEEK, FRANKLIN COUNTY, N. Y., BASED ON 5.2 ACRES OF CALIPERED STRIP

D. B. H. ob. inches.	White pine	Red pine	Scots pine	Norway spruce	Blue spruce	Red spruce	Balsam fir	Sugar maple	Red maple	Black cherry	Fire cherry	Aspen	Beech	Yellow birch
0*	17.31	.....	0.39	75.00	7.12	10.58	13.08	.....	.....	.....	.....	.....	.....	.....
1	50.90	0.576	0.19	124.50	0.96	4.62	5.95	95.10	47.50	9.81	73.40	74.40	28.63	61.90
2	50.40	0.576	20.79	78.50	.....	0.77	1.34	29.20	22.80	15.58	95.10	91.40	6.54	49.60
3	24.80	0.769	22.05	20.29	.....	0.58	1.54	3.27	3.46	15.39	54.00	72.10	0.77	16.70
4	9.60	1.155	16.72	5.57	.....	0.39	0.77	.....	.....	9.81	6.15	36.80	.....	1.34
5	1.54	1.920	11.70	0.39	.....	0.58	0.77	0.19	.....	2.89	0.77	8.84	0.19	0.38
6	.....	1.155	5.38	0.19	.....	0.77	0.58	0.19	.....	0.39	.....	0.77	0.38	.....
7	.....	0.190	0.96	0.19	.....	0.39	0.19	.....	.....	.....	.....	.....	0.38	0.38
8	.....	.....	.....	.....	.....	0.58	.....	.....	.....	.....	.....	.....	.....	0.38
9	.....	.....	.....	.....	.....	.....	0.19	.....	.....	0.39	.....	.....	0.38	.....
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.38
11	.....	.....	.....	.....	.....	0.19	0.19	.....	.....	.....	.....	.....	0.38	.....
12	.....	.....	.....	.....	.....	.....	0.19	.....	.....	.....	.....	.....	0.38	0.38
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.38	.....
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	.....	.....	.....	.....	.....	.....	0.19	.....	.....	.....	.....	.....	.....	.....
Total..	155.35	6.331	78.99	304.63	8.08	19.45	25.18	128.15	76.73	54.26	229.42	284.31	38.41	131.55

* Softwoods less than 4 feet 6 inches in height.

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TABLE X

HEIGHT* IN FEET BY DIAMETER CLASSES FOR THE PRINCIPAL SPECIES ON 1904 PLANTATION, NEAR WAWBEEK, FRANKLIN COUNTY, N. Y., MEASUREMENTS TAKEN JULY, 1919

SPECIES	D. B. H. (ob) INCH CLASSES													
	1		2		3		4		5		6		7	
	*Height in feet	No. of trees measured	*Height in feet	No. of trees measured	*Height in feet	No. of trees measured	*Height in feet	No. of trees measured	*Height in feet	No. of trees measured	*Height in feet	No. of trees measured	*Height in feet	No. of trees measured
Scotch pine	8.75	20	11.65	20	14.25	20	14.80	20	18.70	20	19.95	20	21.75	4
White pine	10.55	20	13.90	20	16.20	20	20.70	20	21.80	9	.....	..	.....	..
Norway spruce	10.35	20	14.55	20	17.60	19	22.00	5	.....	..	.....	..	.....	..
Yellow birch	14.00	20	16.85	20	21.55	20	.....	..	.....	..	.....	..	.....	..
Sugar maple	13.10	20	19.25	20	21.25	14	.....	..	.....	..	.....	..	.....	..
Red maple	14.70	20	19.15	20	21.40	14	.....	..	.....	..	.....	..	.....	..
Black cherry	13.85	20	19.50	20	23.05	20	25.30	20	.....	..	.....	..	.....	..

* Mathematical averages only; not curved.

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Influence of Burning on the Forest

Reproduction on burns is influenced by the size of the area, the severity or number of times burned, and the amount and size of reproduction started at the time of the fire. Type also influences the time necessary for reclaiming such an area.

A large burn on the College forest near Wanakena in St. Lawrence county, was selected for study. The fire occurred in the fall of 1908, and followed the logging operation by about five years. This gave opportunity for hardwood reproduction to start. An area varying in width from eight to twenty chains was covered by strip survey, with square rod sample plots at two-chain intervals. The fire had killed all vegetation except a few large trees in wet spots, but did not destroy the humus except on the outcropping ledges. The area faces in a gentle slope to the southward, and is intersected by one dry watercourse. On the north boundary, near the top of ridge, the fire was checked, and left untouched a stand of hardwood timber. From this a zone of young growth had started, having a width of three to five chains along the edge of the live timber. This zone was not included in the study, although it represents the common condition along the edge of burned areas adjacent to standing hardwood timber.

The presence of such a large number of permanent hardwoods, which is a pronounced feature of this burned area, is probably due to the period of time elapsing between the cutting and burning. A period of about five years elapsed between the logging and the time of the fire. The area was burned but once without serious destruction of the soil cover. It is very doubtful if any appreciable amount of this reproduction is due to storage of seed, since the softwoods are noticeably lacking. In some few places on thin soils over outcropping ledge rock the only tree found is the fire cherry, which exceeds the aspens in ability to endure a dry site. A plantation established on this area with Norway spruce, white pine, and Scotch pine, is only partially successful, due to competition of trees and ferns.

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TABLE XI

NUMBER OF TREES PER ACRE ON BURNED HARDWOOD LAND (BURNED 1908), BASED ON 20.2 ACRES OF CALIPER RECORD—WANAKENA, 1919

D. B. H. CLASS	Spruce	Balsam	Hemlock	Big tooth aspen	Trembling aspen	Black cherry	Fire cherry	Red maple	Sugar maple	Yellow birch	Beech	Miscellaneous	Total
1	0.89	.....	.....	38.90	118.30	51.50	746.00	144.95	59.75	130.00	12.85	1.83	1304.97
2	0.28	.....	.....	15.80	47.40	26.75	50.45	18.75	29.45	13.07	0.83	0.83	203.16
3	0.11	0.05	.....	2.95	8.85	6.67	2.87	3.89	0.05	1.31	0.11	.....	26.86
4	.....	.....	.....	0.40	1.21	0.28	0.83	0.05	0.05	0.28	0.28	.....	3.38
5	.....	.....	.....	.....	0.05	.....	.....	.....	.....	.....	0.05	.....	0.10
6	0.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.05
7	.....	.....	0.05	.....	0.05	.....	.....	.....	.....	0.05	0.05	.....	0.20
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.11	.....	0.11
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.05	.....	0.05
Total	1.13	0.05	0.05	58.05	175.86	85.20	800.15	167.64	89.30	144.71	14.33	2.21	1538.88 checked
AVERAGE D. B. H. IN INCHES AND HEIGHT IN FEET													
D. B. H. inches	.....	.....	.....	1.5	1.3	1.0	0.09	0.09	0.8	1.0	0.8	.....	.....
Height in feet	.....	.....	.....	13.3	12.9	10.6	11.1	11.3	10.9	11.3	9.4	.....	.....

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Influence of Type on Natural Reproduction of Burned Areas:

The marginal line between spruce flat and hardwood areas can often be traced as the lower line of hardwood reproduction, and examination of soil cover shows a deep, dry humus on the lower type. Aspen and fire cherry, with some sprout soft maple, are the first forest cover of the spruce flat type, except on approach to unburned swamps, where balsam establishes itself on the wetter parts.

Heavily burned swamps are very slow in recovery when remote from standing swamp timber areas, and soft maple displaces some of the original spruce and balsam.

Range of Effective Seed Distribution:

The study of the burned area on the College forest was made with the intention of determining the range of effective seeding, but the results showed other factors that made conclusions difficult. Isolated seed trees, change of type with dry humus cover, and most important, sprouting from young fire-killed seedlings which were established by trees now dead, all tend to confuse the original purpose.

Dense stands of young hardwoods extend out for ten chains, in some instances, from the belt of live timber, yellow birch reaching the farthest of the tolerant hardwoods. This is probably the outer limit of effective seeding unless very favorable conditions of grade, wind, and surface prevail.

Growth of Hardwoods

In addition to determining the average number of young trees per acre for the important types and conditions, a comparative study of growth was made to determine their natural competition. Even aged stands along the edge of the land burned in 1903 were selected, the dominant trees of the stand were cut, and complete stem analysis made. While all trees were taken at random, all species were taken from the same local area to get a fair comparison. The exception to this is fire cherry, which does not grow in mixture with tolerant hardwoods, and represents a drier site than that occupied by the other species. All grew on hardwood type of land and in dense stand, so that

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the soil and forest floor conditions were favorable to good growth. The trees are all plotted to fourteen years of age, and diagrams of the same scale are presented for comparison. Height, diameter and form are shown on the diagram in straight lines drawn to points determined by mathematical averages.

The two aspens represent the fastest growth of the temporary stand. The interesting point in comparison of these two is the faster early growth of big-toothed aspen, which later slowed down. At fourteen years the trembling aspen is still increasing its rate of growth. While the two maples and yellow birch have reached a fairly uniform development at fourteen years, the present speed of growth gives hard maple the advantage, and next to this the yellow birch. The development of black cherry is quite remarkable, and would exert an important influence on the subsequent forest if present in sufficient numbers in the reproduction, as in the case of yellow birch. The larger of these black cherry trees will persist and appear in the mature stands as dominants. The growth of beech was very slow in the early ages of its life, and, since the establishment of good forest floor conditions, it is now increasing its rate of growth in spite of it being ten feet less in height than the other competing hardwoods. Many of these beeches are started from root sprouts although they have all the appearance of trees of seed origin. The beech will persist to the final stand and occupy in it eventually a high percentage of crown space. It will, however, be overtopped by several other species of hardwoods.

The fire cherry shows ability to occupy the driest sites in burned over land, and, because of its wide seed distribution and growth in the first few years, seizes land ahead of other species. It does not create a dense shade, but, in thickets, is capable of killing Scotch pine. This is probably due as much to its competition for water as for light. The trees may be ignored in consideration of the final stand, since it loses its dominance and dies quickly on being overtopped.

Pole Stands of Yellow Birch:

In order to determine the growth rate of yellow birch in comparatively pure stand where it is not suppressed in competition by other hardwoods, an attempt was made to find the

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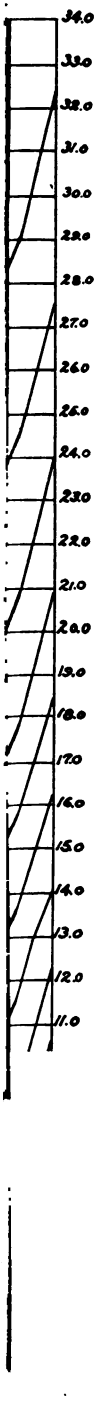

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oldest cuttings available in the Adirondack region. After an extensive inquiry it was found that the oldest clear cuttings of hardwood land dated back about twenty years on the larger logging operations. In three instances, however, pole stands of yellow birch were found which had resulted from fire, and in one case from the clear cutting of hardwoods for charcoal manufacture.

Second Growth Birch at Lake Ozonia:

Such a stand was found near Lake Ozonia in the northwestern Adirondacks, and complete stem analyses were made on trees cut in this stand. While the birch in this instance has grown without overhead competition, at an age of about sixty years, there is a considerable slowing down of volume growth in the last ten years. This is due to some extent to the crowding of trees on the area, and might possibly have been overcome by thinning, but is probably due in a larger measure to a natural tendency of the birch to slow down its growth at about this age. The rate of volume growth would doubtless have been better if the birch had not been forced to contend with the aspen, and had the support of a larger percent of beech and maple in the mixture. A complete statement of existing conditions is given to increase the value of the study for comparative purposes.

Type — Hardwood.

History — Burned over between 1886 and 1880.

Soil — Medium to deep with boulders; drainage, good.

Forest floor — Humus two to three inches, formed from hardwood leaves and litter which is 1½ to 2½ inches deep. No brush or dead wood.

Ground cover — Mountain maple, striped maple, witch hopple and ferns.

Exposure — West to northwest.

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FIGURE 5

Natural reproduction sixty years of age following fire. Upper story aspen followed by yellow birch with an understory of spruce.

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FIGURE 6
Pole stand of yellow birch following fire. Subsequent ground fire has destroyed understory of soft woods.

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Number of trees per acre below one and one-half inches D. B. H.: Hemlock, 140; spruce, 640; white pine, 19; Sugar maple, 5,000; red maple, 1,440; yellow birch, 320; trembling aspen, 480; beech, 140.

This table was computed from eight sample plots scattered over 4.9 acres. Its chief value to show the encroachment of tolerant hardwoods under the shade of yellow birch and other species shown in the attached stand table.

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TABLE XII

NUMBER OF TREES PER ACRE, LAKE OZONIA, FRANKLIN COUNTY, N. Y., SETEMBER, 1919 (BASED ON 4.9 ACRES)

D. B. H. CLASS	White pine	Hemlock	Spruce	Balsam	Sugar maple	Red maple	Trembling aspen	Big tooth aspen	Yellow birch	Beech	Fire cherry	Total of all species
1	0.75	29.16	52.20	2.56	47.76	6.12	.....	.....	135.98	12.34	.....	286.87
2	2.28	21.66	16.98	2.56	17.16	1.20	.....	1.29	222.90	16.34	.....	302.28
3	.....	5.32	8.36	.....	5.30	3.66	3.82	1.28	223.30	7.58	2.72	261.34
4	.....	0.75	2.46	.....	2.46	.....	6.58	2.56	127.22	3.72	2.72	148.47
5	.....	.....	.....	.....	.....	1.28	16.44	3.72	79.62	1.20	2.72	104.93
6	.....	.....	.....	.....	.....	.....	14.80	2.42	33.30	2.56	1.30	54.38
7	0.75	.....	.....	.....	.....	1.28	8.68	7.58	10.50	1.20	.....	29.99
8	.....	.....	.....	.....	.....	.....	2.46	7.68	10.04	.....	.....	20.18
9	.....	.....	.....	.....	.....	.....	2.46	3.82	.....	.....	.....	6.28
10	.....	.....	.....	.....	.....	.....	.....	.....	1.20	.....	.....	1.20
11	0.75	.....	.....	.....	.....	.....	.....	1.20	.....	.....	.....	1.95
12	.....	.....	.....	.....	.....	.....	2.46	.....	.....	.....	.....	2.46
13	.....	.....	.....	.....	.....	.....	.....	1.28	.....	.....	.....	1.28
14	.....	.....	.....	.....	.....	.....	1.20	.....	.....	.....	.....	1.20
Total	4.53	56.89	80.00	5.12	72.68	13.54	58.90	32.74	844.06	44.94	9.46	1222.81

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TABLE XIII

YELLOW BIRCH, HEIGHT, DIAMETER, AND VOLUME GROWTH, LAKE OZONIA, FRANKLIN COUNTY, N. Y., 1919

AGE	Total height	D. B. H.	Total volume in cubic feet
10	13.8	1.3	0.14
20	28.1	2.9	0.64
30	38.4	4.3	1.96
40	44.6	5.1	2.52
50	49.7	5.9	3.78
60	53.6	6.5	4.66

A study of birch growing under shade of adjoining hardwoods shows at sixty years of age about 50 per cent of the height and diameter development found in the trees of the same age grown in the open.

Height growth studies made on 170 spruce trees grown under shade of yellow birch at Lake Ozonia shows an annual height growth of about two-tenths of a foot. While this is relatively slow, it is faster than that of spruce under mixed hardwoods. Stands of this type can be profitably thinned to allow increased growth of the spruce understory.

Birch, second growth — St. Lawrence County:

A second area of pole stand of yellow birch and aspen was found in southeast St. Lawrence county, and data are submitted to show the result of slightly different conditions. This area of some twenty-five acres is found on spruce flat type, and was burned about forty years ago, followed by reproduction and a light ground fire about ten years ago on part of the area. Strips and sample plots were run on twenty-three acres of the area, and the results shown in four tables (14, 15, 16 and 17). The effect of the second ground fire was to kill a number of the smaller birch, hasten the destruction of the aspen, thin the crown of the stand, and allow considerable reproduction of intolerant species. The amount of soft wood reproduction was doubtless reduced in number. It can be readily seen that the aspen is decadent, and was once the dominant tree on the area.

A third area was studied and results found comparable to the preceding two, which makes it obvious that small burns sur-

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TABLE XIV

NUMBER OF LIVE TREES PER ACRE POLE STAND OF YELLOW BIRCH, SOUTHEAST ST. LAWRENCE COUNTY, NEAR CRANBERRY LAKE, 1919

D. B. H. Class ob.	White pine	Spruce	Balsam	Sugar maple	Red maple	Trembling aspen	Big tooth aspen	Yellow birch	Beech	Fire cherry	Total of all species
1	0.22	7.12	1.33	0.22	3.15	14.20	.....	10.55	.....	13.85	50.64
2	0.44	8.23	0.22	0.22	0.67	.....	.....	82.89	2.00	.....	94.67
3	0.44	1.55	0.22	.....	0.44	.....	.....	131.50	0.89	.....	135.04
4	0.44	2.44	0.22	0.22	0.44	.....	1.11	123.10	0.67	.....	128.64
5	0.89	0.67	.....	.....	0.67	.....	1.77	69.45	0.22	0.22	93.89
6	0.67	1.33	.....	.....	0.89	0.22	2.22	34.25	.....	.....	39.58
7	0.44	0.67	.....	.....	0.89	1.11	2.89	10.88	.....	0.22	17.10
8	0.89	.....	.....	.....	0.22	0.67	5.34	6.89	0.44	.....	14.45
9	1.55	0.22	0.22	.....	.....	0.67	3.33	0.89	0.44	.....	7.32
10	0.89	.....	0.22	.....	0.22	1.55	6.23	0.44	0.22	.....	9.77
11	0.67	0.22	.....	.....	.....	1.55	4.01	0.67	0.22	.....	7.34
12	0.89	.....	.....	.....	.....	0.67	5.34	0.22	.....	.....	7.12
13	0.22	0.22	.....	.....	.....	0.22	3.15	.....	.....	.....	3.81
14	0.44	.....	0.22	.....	0.22	0.44	2.00	.....	.....	.....	3.32
15	0.22	.....	.....	.....	.....	0.44	1.55	0.22	.....	.....	2.43
16	.....	.....	.....	.....	0.22	0.44	0.89	.....	.....	.....	1.55
17	.....	.....	.....	.....	.....	0.22	.....	.....	.....	.....	.....
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	9.31	22.67	2.65	0.66	9.03	22.40	39.83	471.95	5.10	14.29	586.89

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TABLE XV

NUMBER OF DEAD TREES PER ACRE, SAME STAND AS TABLE XIV

D. B. H. CLASS ob.	SPECIES										
	White pine	Spruce	Balsam	Yellow birch	Trembling aspen	Big tooth aspen	Red maple	Sugar maple	Fire cherry	Beech	Totals
1	.....	1.00	.....	31.50	.....	.....	.....	.....	.....	0.50	33.0
2	0.50	3.00	.....	141.50	0.50	.....	1.00	.....	0.50	0.50	147.5
3	.....	2.00	.....	79.50	3.50	.....	.....	.....	2.50	1.00	88.5
4	0.50	1.50	.....	36.00	1.50	.....	.....	.....	1.50	.....	41.0
5	1.00	1.50	.....	15.00	3.00	.....	.....	.....	2.00	.....	22.5
6	0.50	1.50	0.50	6.50	1.00	.....	.....	.....	.....	1.00	11.0
7	.....	1.00	.....	.....	1.00	0.50	.....	.....	.....	.....	2.5
8	.....	0.50	.....	.....	1.50	2.50	0.50	.....	.....	.....	5.0
9	.....	.....	.....	0.50	2.50	0.50	.....	.....	.....	.....	3.5
10	0.50	.....	.....	.....	1.50	.....	.....	.....	.....	.....	2.0
11	0.50	.....	1.00	.....	1.50	0.50	.....	.....	.....	.....	3.5
12	.....	0.50	.....	.....	0.50	.....	.....	.....	.....	.....	1.0
13	.....	.....	.....	.....	1.50	0.50	.....	.....	.....	.....	2.0
14	.....	.....	0.50	.....	1.00	.....	.....	.....	.....	.....	1.5
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	.....	.....	.....	.....	0.50	.....	.....	.....	.....	.....	0.5
Total	3.50	12.50	2.00	310.50	21.00	4.50	1.50	.....	6.50	3.00	365.0

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rounded by standing timber may be expected to reproduce readily to birch in addition to the aspen, and that these two form a nurse crop under which the more tolerant hardwoods and softwoods enter. The subsequent history is not clear since areas burned more than sixty years ago were not found.

TABLE XVI

REPRODUCTION PER ACRE LESS THAN ONE-HALF INCH IN DIAMETER BASED ON REPRODUCTION COUNT OF TWENTY-THREE PLOTS ON TWENTY-THREE ACRES, SOUTHEAST ST. LAWRENCE COUNTY, NEAR CRANBERRY LAKE, 1919

SPECIES	No. per acre	SPECIES	No. per acre
White pine	14	Big toothed aspen	175
Spruce	202	Yellow birch	2805
Balsam	243	Fire cherry	153
Sugar maple	335	Black cherry	27
Red maple	3995	Beech	291
Trembling aspen	222	Total number per acre	8462

TABLE XVII

COMPARISON OF DEVELOPMENT OF YELLOW BIRCH AND ASPEN, SAME AREA AS IN PRECEDING THREE TABLES

D. B. H. CLASS ob.	YELLOW BIRCH — AVERAGE VALUES (CURVED)			BIG TOOTH ASPEN — AVERAGE VALUES (CURVED)		
	D. B. H. outside bark	Cl. length	Total height	D. B. H. outside bark	Cl. length	Total height
1	.....	4.0	11.0	.....	6.0	9.0
2	2.0	7.5	19.0	.....	9.5	16.5
3	3.1	10.3	26.0	.....	13.0	22.5
4	3.9	12.7	31.5	.....	16.0	28.0
5	5.0	15.0	36.0	.....	18.5	33.5
6	5.7	16.5	40.0	6.0	20.5	38.0
7	7.0	18.0	43.0	7.0	22.0	42.0
8	.....	19.0	44.5	8.1	24.0	45.5
9	8.7	19.5	46.0	.....	25.5	48.5
10	.....	.....	.....	10.3	26.5	51.0
11	.....	.....	.....	11.0	27.5	53.5
12	.....	.....	.....	11.7	28.5	55.0
13	.....	.....	.....	13.0	29.5	56.5
14	.....	.....	.....	14.1	31.0	57.7
15	.....	.....	.....	14.9	32.5	58.5
16	.....	.....	.....	15.9	34.0	59.7

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FIGURE 7
Natural reproduction on clean cut land yielding thirteen cords per acre in twenty-three years. Northern Adirondacks.

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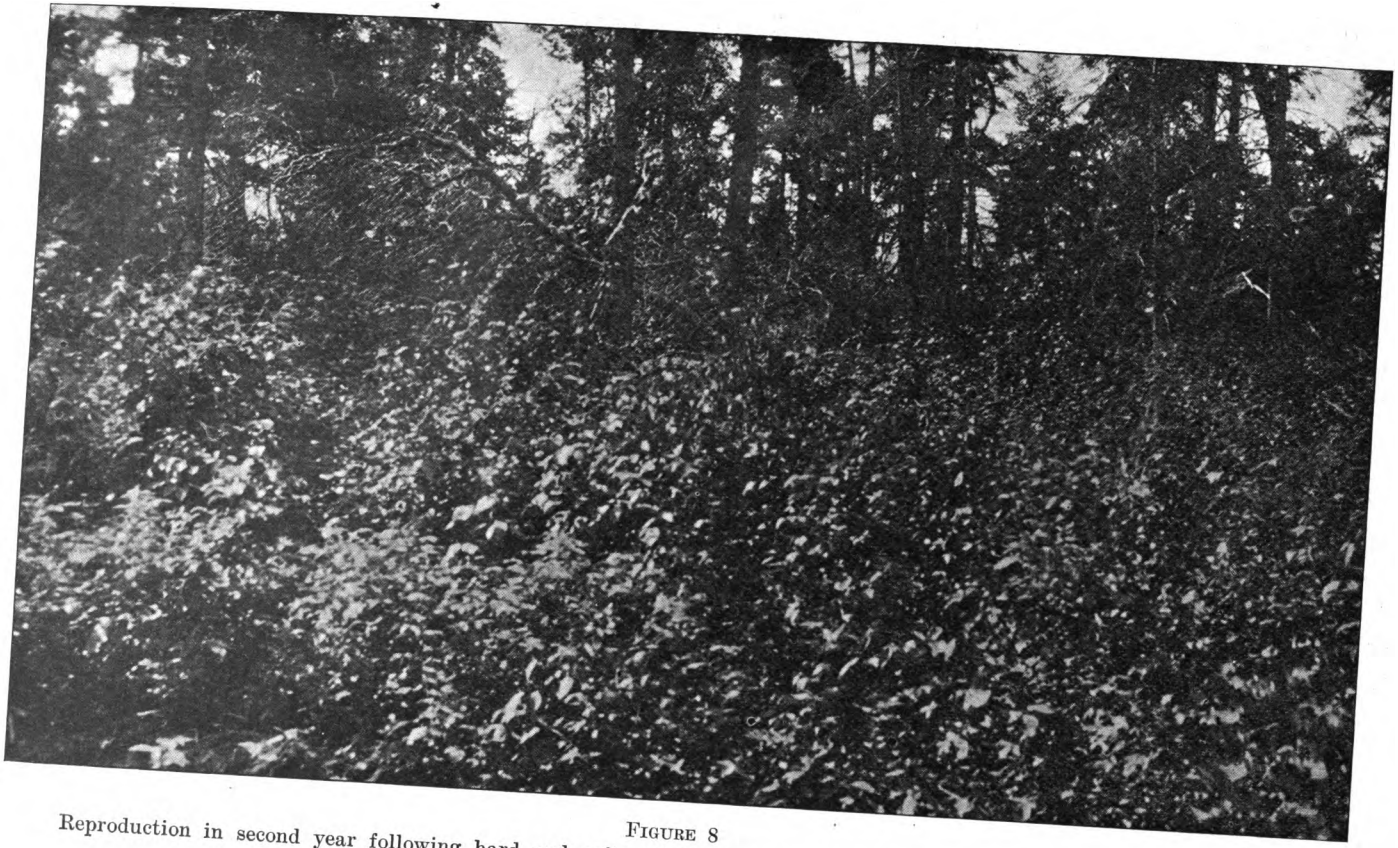

FIGURE 8

Reproduction in second year following hard and softwood logging operation of Emporium Forestry Company land.

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A study was made of the volume of mature yellow birch on the logging operations of the Emporium Forestry Company in southeastern St. Lawrence county. Trees were measured as cut in the regular logging operations of the Emporium Forestry Company, and scaled in the log lengths found by Scribner Rule. Utilization in the tops approximated eight inches and long logs up to twenty feet were cut. The close utilization in length of the logs tended to decrease the volume for individual diameter classes.

This table is submitted as showing the volume ruled of an actual logging operation under present conditions of utilization.

Growth, height, diameter and volume were computed by complete stem analyses of the trees.

TABLE XVIII

VOLUME TABLE FOR YELLOW BIRCH BASED ON MERCHANTABLE CONTENTS IN BOARD FEET, SCRIBNER RULE, ON MEASUREMENTS ON 351 TREES, TOWN OF COLTON, COUNTY OF ST. LAWRENCE, N. Y.

D. B. H. outside bark	VOLUME IN BOARD FEET—SCRIBNER RULE						
	NUMBER OF SIXTEEN FOOT LOGS						
	1 log	1½ logs	2 logs	2½ logs	3 logs	3½ logs	Number of trees
10.....	32	43	55	...	...	....	2
11.....	36	48	60	72	...	....	5
12.....	41	53	66	80	...	....	27
13.....	47	60	75	95	...	....	24
14.....	54	67	86	106	...	....	38
15.....	51	77	97	122	145	168	23
16.....	68	84	107	140	166	198	133
17.....	76	96	123	158	193	229	31
18.....	84	108	139	175	217	262	18
19.....	93	121	157	200	246	300	27
20.....	102	136	177	224	281	345	23
21.....	112	150	198	254	317	392	21
22.....	123	169	222	285	357	445	18
23.....	135	186	245	317	400	496	9
24.....	148	206	271	350	441	550	18
25.....	162	223	296	385	495	621	10
26.....	177	243	324	418	538	678	4
27.....	193	264	351	452	590	750	9
28.....	210	286	382	500	645	830	5
29.....	229	310	420	549	710	920	5
30.....	250	336	452	598	775	1050	8
Total..	...	...	...	...	...	....	351

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TABLE XIX

YIELD TABLE

YELLOW BIRCH, TOWN OF COLTON, ST. LAWRENCE COUNTY, N. Y. (BASED ON 208 TREES)

AGE IN YEARS	D. B. H. ob in inches	Total height in feet	Clear length in feet (curved)	Merchantable length in feet (2′ stump)	Yield in board feet, Scribner Rule (to 8″ top d. i. b.)
10	0.25	5.5	2.7	..	...
20	1.1	13.5	5.1	..	...
30	1.9	19.5	7.5	..	...
40	2.9	26.8	9.8	..	...
50	3.8	33.1	11.8	..	...
60	4.9	38.5	13.7	..	...
70	5.9	43.8	15.6	..	...
80	6.8	48.2	17.3	..	...
90	7.7	50.9	19.0	..	...
100	8.9	53.3	20.5	8	10
110	9.1	55.7	22.0	12	25
120	11.1	58.0	32.4	16	44
130	12.3	60.3	24.9	24	64
140	13.4	62.5	26.0	30	87
150	14.5	64.6	27.1	32	112
160	15.6	66.6	28.2	32	139
170	16.6	68.6	29.2	40	175
180	17.7	70.5	30.2	42	210
190	18.7	72.3	31.1	48	250
200	19.8	73.9	32.0	50	295
210	20.8	75.1	32.8	52	345
220	21.7	76.1	33.6	54	399
230	22.6	77.0	34.3	56	450
240	23.6	77.9	35.0	56	500
250	24.4	78.7	35.7	58	553
260	25.2	79.4	36.3	58	600
270	25.9	80.1	36.9	60	637
280	26.6	80.7	37.5	60	608
290	27.2	81.2	38.0	60	695
300	28.8	81.7	38.5	62	720

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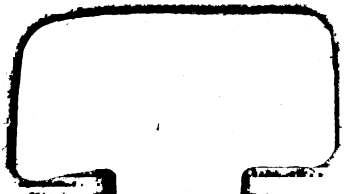

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